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Percutaneous endoscopic gastrostomy versus percutaneous radiological gastrostomy for swallowing disturbances (Review)

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Percutaneous endoscopic gastrostomy versus percutaneous radiological gastrostomy for swallowing disturbances.
Cochrane Database of Systematic Reviews 2016, Issue 2. Art. No.: CD009198.
DOI: 10.1002/14651858.CD009198.pub2.

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[Intervention Review]

Percutaneous endoscopic gastrostomy versus percutaneous radiological gastrostomy for swallowing disturbances

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Editorial group: Cochrane Upper GI and Pancreatic Diseases Group.
Publication status and date: New, published in Issue 2, 2016.

Citation: Yuan Y, Zhao Y, Xie T, Hu Y. Percutaneous endoscopic gastrostomy versus percutaneous radiological gastrostomy for swallowing disturbances. *Cochrane Database of Systematic Reviews* 2016, Issue 2. Art. No.: CD009198. DOI: 10.1002/14651858.CD009198.pub2.

ABSTRACT

Background

Gastrostomy has been established as the standard procedure for administering long-term enteral nutrition in individuals with swallowing disturbances. Percutaneous gastrostomy is a less-invasive approach than open surgical gastrostomy, and can be accomplished via endoscopy (percutaneous endoscopic gastrostomy or PEG) or sonographic or fluoroscopic guidance (percutaneous radiological gastrostomy or PRG). Both techniques have different limitations, advantages, and contraindications. In order to determine the optimal technique for long-term nutritional supplementation many studies have been conducted to compare the outcomes of these two techniques; however, it remains unclear as to which method is superior to the other with respect to both efficacy and safety.

Objectives

To compare the safety and efficacy of PEG and PRG in the treatment of individuals with swallowing disturbances.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*, January 2016); MEDLINE (1946 to 22 January 2016); EMBASE (1980 to 22 January 2016); the reference lists of identified articles; databases of ongoing trials, including the Chinese Cochrane Centre Controlled Trials Register; and PubMed. We applied no language restrictions.

Selection criteria

Randomised controlled trials (RCTs) comparing PEG with PRG in individuals with swallowing disturbances, regardless of the underlying disease.

Data collection and analysis

Two authors independently evaluated the search results and assessed the quality of the studies. Data analyses could not be performed as no RCTs were identified for inclusion in this review.

Main results

We identified no RCTs comparing PEG and PRG for percutaneous gastrostomy in individuals with swallowing disturbances. The large body of evidence in this field comes from retrospective and non-randomised controlled studies and case series. Based on this evidence, both PEG and PRG can be safely performed in selected individuals, although both are associated with major and minor complications. A definitive RCT has yet to be conducted to identify the preferred percutaneous gastrostomy technique.

Authors' conclusions

Both PEG and PRG are effective for long-term enteral nutritional support in selected individuals, though current evidence is insufficient to recommend one technique over the other. Choice of technique should be based on indications and contraindications, operator experience and the facilities available. Large-scale RCTs are required to compare the two techniques and to determine the optimal approach for percutaneous gastrostomy.

PLAIN LANGUAGE SUMMARY

Comparision of two techniques for the placement of a feeding tube to the stomach through the skin in an individual who has difficulty swallowing food

Review question

This systematic review was conducted to compare two different methods for placing a feeding tube to the stomach via an opening in the skin (known as percutaneous gastrostomy) in order to provide food to an individual with swallowing difficulties; the aim was to find the most effective and safe approach.

Background

Placing a feeding (gastric) tube to the stomach percutaneously (through an opening in the skin) is a less-invasive method than open surgery. Percutaneous gastrostomy can be guided either using an optical instrument (or endoscope) that can be used to look inside the body (termed percutaneous endoscopic gastrostomy or PEG) or using guidance from external techniques that are used to obtain an image of the inside of the body (known as percutaneous radiological gastrostomy or PRG). Both PEG and PRG are associated with high rates of success in the placement of gastric tubes, but which is the best method has yet to be determined.

Study characteristics

We searched a number of online resources to identify studies that compared PEG and PRG in individuals with swallowing disturbances in a randomised controlled manner. This type of study is the best research method for identifying any differences between two techniques used for the same procedure.

Key results

We identified no randomised controlled studies comparing PEG and PRG in individuals with swallowing disturbances. Because of this lack of evidence, we are therefore not currently able to determine which technique is superior to the other for the placement of a gastric tube, and can make no definitive recommendations. Randomised controlled trials are required in order to determine the optimal method for percutaneous gastrostomy in individuals with swallowing difficulties.

SUMMARY OF FINDINGS

Summary of findings for the main comparison.

Percutaneous endoscopic gastrostomy compared with percutaneous radiological gastrostomy for swallowing disturbances

Population: Individuals with swallowing disturbances

Intervention: Percutaneous endoscopic gastrostomy (PEG)

Comparison: Percutaneous radiological gastrostomy (PRG)

Outcomes	Comments
No randomised controlled trial was identified for inclusion in this review. No sound conclusions could not be reached regarding a comparison of outcomes between PEG and PRG.	The large body of evidence in this field comes from retrospective and non-randomised controlled studies and case series, which have shown the feasibility and safety of PEG and PRG in selected populations. Randomised controlled trials are required to establish the optimal method for percutaneous gastrostomy. At present, PEG or PRG should be selected on the basis of patient indications and contraindications, the operator's experience and the facilities available.

BACKGROUND

Description of the condition

Swallowing is a complex process coordinated by many nerves and muscles that lie between the pharynx and the stomach. Problems at any point between the mouth and the stomach can lead to a disturbance in swallowing, which can impede the transport of liquids or solids, or both, down the gastrointestinal tract. Many conditions can give rise to a disturbance in swallowing: mechanical obstruction (e.g. oesophageal cancer, peptic stricture, Zenker's diverticulum, extrinsic compression) and neurological or muscular disorders (e.g. stroke, achalasia, multiple sclerosis, Parkinson's disease and infections such as syphilis). Swallowing disturbances affect up to half of individuals who have experienced a stroke, leading to potentially fatal complications such as malnutrition and aspiration of the digestive juice (Singh 2006; Walter 2007). Nutritional support is very important for individuals who have swallowing disturbances.

Description of the intervention

There are two main ways to administer nutritional substances to individuals with swallowing difficulties: via a nasogastric tube or via gastrostomy, a surgical procedure for placing a tube into the stomach through the abdominal wall. Gastrostomy is widely used for providing enteral nutrition in individuals with swallowing disturbances or for palliating the drainage of gastric juice and secretions. It can be performed by open surgery or percutaneously. Percutaneous techniques are more frequently used than open surgery so as to avoid the risks associated with general anaesthesia and laparotomy (Galletti 2001). Percutaneous gastrostomy can be achieved via interventional radiology or endoscopy. The first percutaneous endoscopic gastrostomy (PEG), using a flexible and illuminated instrument passed orally into the stomach to assist with the placement of the nutritional tube into the stomach through the skin, was successfully performed by Gauderer and Ponsky in 1979 (Gauderer 1980), which is widely called "pull-type" gastrostomy. The "push-type" endoscopic gastrostomy differs from the "pull-type" in that the gastrostomy tube is pushed over the guide-wire from the mouth to stomach other than being pulled through the alimentary tract (Sacks 1983). Another modification of endoscopic gastrostomy is the "introducer" method, in which the gastrostomy tube is inserted directly through a peel-away sheath into the stomach under endoscopic guidance (Moran 1990). In 1981, Preshaw introduced percutaneous radiological gastrostomy (PRG) (sometimes also named radiologically inserted gastrostomy or RIG), which enables the successfully placement of the nutritional tube by means of sonographic or fluoroscopic guidance rather than via endoscopy or open surgery (Preshaw 1981).

Nowadays, percutaneous gastrostomy approaches have replaced surgical gastrostomy for reasons of simplicity, safety and effectiveness. As a general rule, gastrostomy should be considered for individuals whose nutritional intake will be insufficient for more than two to three weeks (Loser 2005). It can also be used for decompression of the stomach and small bowel (Herman 1992). Some conditions are deemed to be contraindications to percutaneous gastrostomy, such as severe ascites, peritonitis, serious coagulation disorders, interposed liver or colon, severe carcinomatosis of the peritoneum, serious psychosis and a short life expectancy (ASGE 1998; Greff 1999).

Some individuals who have undergone PEG or PRG may develop complications. Haemorrhage requiring blood transfusion or laparotomy, peritonitis, fistulas between the stomach and adjacent viscera, bowel perforation, aspiration of material in the airways, heart failure, respiratory failure, heart and respiratory failure, sepsis, necrotising fasciitis, metastatic tumour implantation into the stoma and loss of catheter tract are considered major complications that are life-threatening and may require aggressive intervention. Categorised as minor complications requiring minimal intervention are abdominal pain with or without peritoneal involvement, wound infection, fever, peristomal leaks, wound granulation or bleeding, gastroparesis, regurgitation or reflux, and minor gastric tube problems (Galaski 2009). In a meta-analysis, PRG has been shown to be associated with lower rates of major complications than PEG (5.9% versus 9.4%, respectively), but higher rates of minor complications (7.8% versus 5.9%, respectively) (Wollman 1995).

How the intervention might work

For individuals with swallowing disturbances, percutaneous gastrostomy is a well-established technique for providing enteral nutrition support. Both PEG (by pull-type or push-type tubes) and PRG are options for the percutaneous placement of a nutritional tube. A meta-analysis has reported the rate of successful tube placement to be 99.2% with PRG and 95.7% with PEG (Wollman 1995). Likewise, in a recent study of PRG, the reported success rate was 100%, even in a series of individuals in many of whom PEG had either failed or was not considered an option (Dinkel 2002). Both approaches have clear clinical value in individuals with swallowing disturbances: both can provide the essential nutritional support required without the discomfort that many individuals with no appetite report when taking oral nutritional supplements (Loser 2005). Some studies have also demonstrated that acceptance and tolerance of enteral nutrition, and the consequent improvement in malnutrition and quality of life, in individuals who have undergone percutaneous gastrostomy via either technique are excellent (Bannerman 2000; Loser 1998; Loser 2003; Senft 1993).

Why it is important to do this review

There are many studies reporting the efficacy and safety of PEG and PRG. However, the optimal technique for gastrostomy in individuals with swallowing disturbances remains unknown. It seems that PEG is used more widely than PRG for long-term enteral nutritional support, and some authors consider PEG to be the superior method for nutritional support (Galletti 2001; Grant 2009; Rustom 2006). In contrast, because of a higher success rate and lower risk of aspiration, PRG is preferred over PEG by other authors (Chio 2004; Desport 2005; Thornton 2002).

A meta-analysis of published literature (involving 5680 participants) conducted by Wollman 1995 found that PRG was associated with a higher success rate and less morbidity than PEG. In contrast, another meta-analysis focusing on individuals with neck and head cancer (2353 participants) found PRG to be associated with a higher number of major complications than PEG (Grant 2009). These conflicting results from two meta-analyses should be interpreted with extreme caution because all the included studies were case series and not randomised controlled trials (RCTs), which might have resulted in significant bias. In addition, disparities also existed between included studies in terms of survival rates. A longer survival was reported following PRG in

Chio 2004, whereas a more recent study reported the PEG and PRG to have similar 30-day and 1-year survival rates (Leeds 2010).

To date, a definitive conclusion has yet to be reached regarding which technique, PRG or PEG, is the most effective for the placement of a gastric tube in individuals with swallowing disturbances; hence, it is important and necessary to carry out this systematic review.

OBJECTIVES

To compare the safety and efficacy of PEG and PRG in the treatment of individuals with swallowing disturbances.

METHODS

Criteria for considering studies for this review

Types of studies

We intended to include RCTs (of all designs) comparing PEG and PRG in individuals with swallowing disturbances.

Types of participants

We considered all individuals with swallowing disturbances who required enteral feeding and were randomised to PEG or PRG to be eligible for inclusion in this review, regardless of the cause of the disturbance (baseline disease), participant age, gender, etc. Individuals with an indication of decompression were excluded.

Types of interventions

The comparison arms of this review were:

1. PEG (via any method: pull- or push-type tubes, introducer technique);
2. PRG (via any guidance technique: sonographic or fluoroscopic).

Types of outcome measures

Primary outcomes

- Mortality rate

Secondary outcomes

- Success rate of tube placement
- Major complication rate (any of the following was regarded as a major complication: haemorrhage requiring blood transfusion or laparotomy, peritonitis, fistulas between the stomach and adjacent viscera, bowel perforation, aspiration of material in the airways, heart failure, respiratory failure, heart and respiratory failure, sepsis, necrotising fasciitis, metastatic tumour implantation into the stoma, loss of catheter tract)
- Minor complication rate (any of the following was regarded as a minor complication: abdominal pain with or without peritoneal involvement, wound infection, fever, peristomal leak, wound granulation or bleeding, gastroparesis, regurgitation or reflux, minor tube problems requiring minimal intervention)
- Duration of the procedure
- Need for analgesia or sedation for the procedure
- Improvement in malnutrition
- Cost of the procedure
- Length of hospital stay
- Quality of life

Search methods for identification of studies

Electronic searches

We searched the following databases:

- The Cochrane Central Register of Controlled Trials (CENTRAL) (*The Cochrane Library*, January 2016) (Appendix 1);
- MEDLINE (1946 to November 22 January 2016) (Appendix 2);
- EMBASE (1980 to 22 January 2016) (Appendix 3).

Searching other resources

We searched the following clinical trial registers:

- The Chinese Cochrane Centre Controlled Trials Register (www.chictr.org);
- National Institute of Health Clinical Trials Database (www.clinicaltrials.gov);
- Current Controlled trials (www.controlled-trials.com);
- Center Watch (www.centerwatch.com).

We also searched PubMed and the reference lists of identified articles for eligible studies. We applied no language restrictions.

Data collection and analysis

Selection of studies

Two authors (Yong Yuan and Yang Hu) independently reviewed the titles, abstracts and full texts of studies and considered them for inclusion. We used the methods recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011) to identify multiple reports of the same study, and we corresponded with the original authors by phone or mail, when necessary, in order to clarify the eligibility of studies. We resolved any disagreements on the selection of studies for inclusion by consensus discussion or by consulting a third party.

Data extraction and management

We extracted data concerning details of participants' characteristics, methods, interventions and outcomes using a data extraction form. Disagreements were resolved by discussion or arbitrated by another author. Microsoft Excel was used for data management. However, no RCT was identified for inclusion.

Assessment of risk of bias in included studies

We intended to assess the risk of bias of the included studies using the approach recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011):

1. details of randomisation method;
2. allocation concealment;
3. blinding of participants and personnel;
4. blinding of outcome assessment;
5. incomplete outcome data;
6. selective outcome reporting;
7. other sources of bias.

However, as we identified no RCTs for inclusion, this was not carried out.

Measures of treatment effect

We planed to express the treatment effect as risk ratio (RR) with 95% confidence intervals (CIs) for dichotomous outcomes and the mean difference (MD) or standardised mean difference (SMD) (with 95% CIs) for continuous outcomes.

Unit of analysis issues

To ensure that the analysis matched the level of randomisation, we planned to identify variations in the designs of included studies (e.g. simple parallel group design, cluster-randomised trial, repeated measurements, recurring events, etc.). As this review was investigating surgical procedures we intended to include both cluster-randomised and individually randomised trials. If cluster-randomised trials had been included and the data had been analysed appropriately, we would have analysed the data using the Generic Inverse Variance method. Where the same participant was included more than once, we would have included only the first episode of treatment and if participants had been allowed to cross over into another arm, we would have analysed the data strictly according to intention-to-treat (ITT) principles.

Dealing with missing data

If data were missing, we intended to try to obtain these data from the original authors whenever possible, perform sensitivity analyses and address the potential impact of the missing data on the findings of the review in the Discussion section, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).

Assessment of heterogeneity

We intended to assess heterogeneity using a standard Chi^2 test, with significance being set at P level < 0.1, or using an I^2 statistic > 75% to indicate significant heterogeneity.

Assessment of reporting biases

We planned to identify and minimise reporting biases (publication bias, time lag bias, duplicate publication bias, location bias, citation bias, language bias and outcome reporting bias) by carrying out a comprehensive search for studies, including unpublished studies and using trial registries to identify ongoing studies. We intended to assess reporting bias using funnel plot asymmetry testing, if necessary, performing sensitivity analyses if we found evidence of small study effects.

Data synthesis

We intended to perform a meta-analysis of all RCTs comparing PEG with PRG in individuals with swallowing disturbances. We planned to consider all the outcomes specified for data synthesis, and choose a random-effects model for the primary analysis. We would then have used a fixed-effects model as a sensitivity analysis to check that the results were robust regardless of the method chosen.

Subgroup analysis and investigation of heterogeneity

We intended to explore the following potential sources of heterogeneity using subgroup analyses or meta-regression:

1. differences in follow-up period;
2. differences in surgical procedure: pull-type or push-type method, guidance by sonography or fluoroscopy, etc.
3. differences in the baseline disease causing the swallowing disturbance, such as previous surgery, trauma, cerebrovascular diseases, immunodeficiency diseases, head and neck neoplasms, etc.

Sensitivity analysis

We planned to undertake sensitivity analyses to explore potential influences on effect size. If we identified heterogeneity resulting from low-quality trials, we intended to exclude the lowest-quality trials from the review.

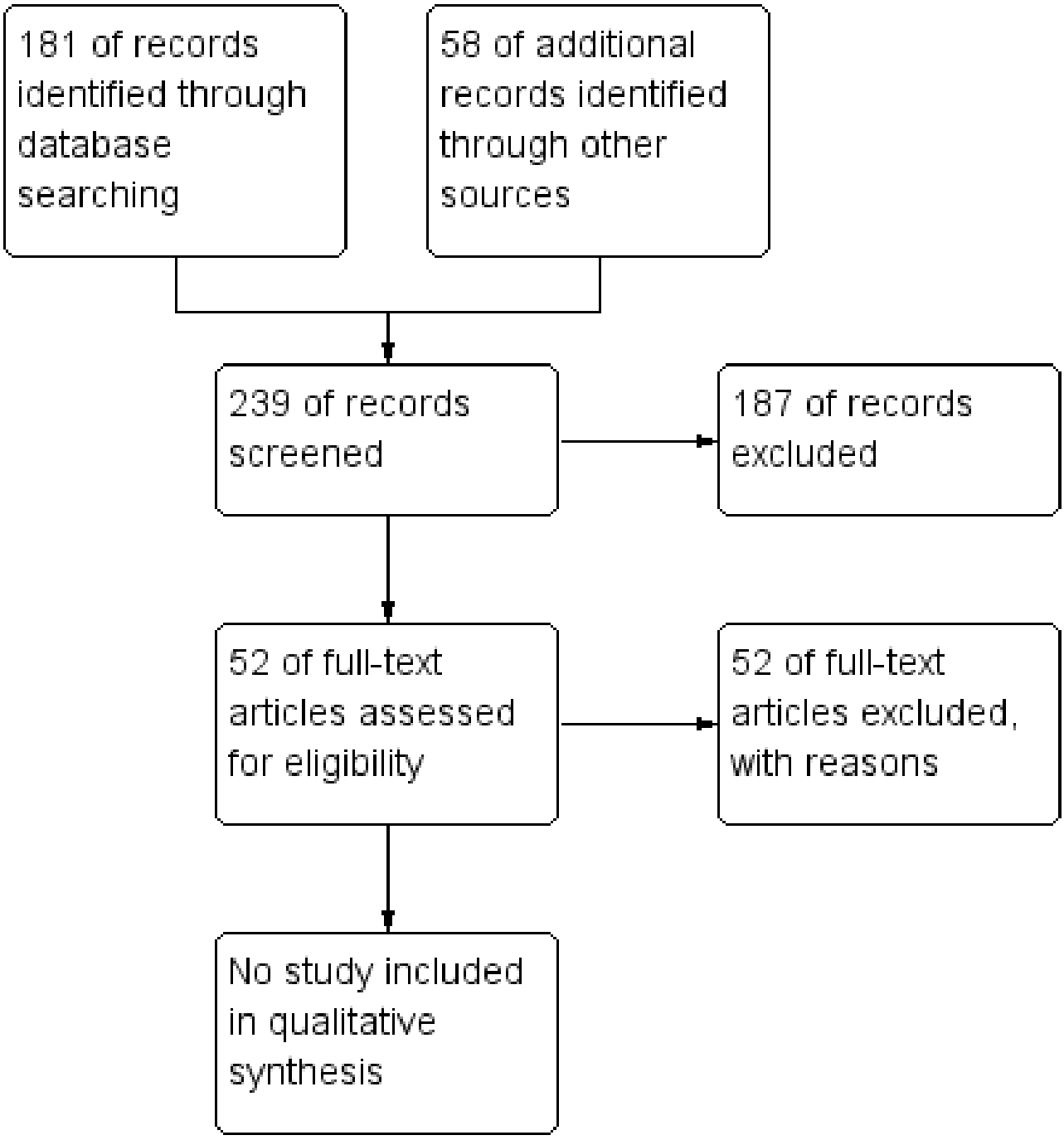
RESULTS

Description of studies

Results of the search

We identified a total of 239 studies from the initial search (MEDLINE = 89, EMBASE = 76, CENTRAL = 16, and an additional 58 records from other sources). After removing obviously irrelevant records and duplicates, 52 studies remained. After reading the abstracts and full texts, we identified no RCTs for inclusion (Figure 1). We describe the reasons for study exclusion in the Characteristics of excluded studies section.

Figure 1. Study flow diagram.



Included studies

We identified no RCTs comparing the outcomes following PEG or PRG in individuals with swallowing disturbances, and included no study for data analysis in this review.

Excluded studies

We excluded most studies on the basis that they were retrospective studies, case series or non-randomised controlled studies, as shown in the Characteristics of excluded studies section.

Risk of bias in included studies

We included no studies for data analysis in this review.

Effects of interventions

See: **Summary of findings for the main comparison**

As we identified no RCTs for inclusion in this review, no sound conclusions could be drawn.

DISCUSSION

The maintenance of nutrition is of central importance in individuals with swallowing disturbances. Gastrostomy has become the standard procedure for long-term enteral nutritional supplementation, and can be achieved by surgery, or percutaneously via endoscopy or radiological imaging. Most reports advocate percutaneous gastrostomy as superior to open surgery (Silas 2005), being associated with less trauma, and lower complication rates and costs. As a result, surgery usually serves as a second choice when individuals have failed a percutaneous technique. As for which percutaneous technique is the most effective and safe, percutaneous endoscopic gastrostomy (PEG) or percutaneous radiological gastrostomy (PRG), this remains a matter of debate as our comprehensive search of the literature failed to identify definitive prospective randomised controlled trials (RCTs) comparing these two techniques. The following sections are based on the evidence available, derived from retrospective studies, case series or non-randomised controlled studies.

Indications and contraindications for PEG/PRG

Percutaneous gastrostomy, either PEG or PRG, is usually indicated in individuals with disorders of swallowing that require long-term nutritional support. Such individuals may suffer from head or neck cancer, oesophageal cancer, or neurological or muscular disorders (e.g. stroke, achalasia, multiple sclerosis, Parkinson's disease). Individuals with some systemic diseases, including Crohn's disease, scleroderma and radiation enteritis, may also benefit from gastrostomic feeding (Given 2005). In addition, percutaneous gastrostomy can also be used as a method of decompression, rather than nutritional support, in individuals with gastric outlet obstruction.

Contraindications to both PEG and PRG

A common contraindication to both PEG and PRG is uncorrectable coagulopathy.

Contraindications to PEG

Endoscopic gastrostomy can be contraindicated in conditions that make endoscopy difficult or impossible (e.g. neoplastic lesions of the upper gastrointestinal tract, large Zenker's diverticulum and severe oesophageal stenosis) (Thornton 2000). In addition, PEG may fail in individuals with a high subcostal stomach or obesity, because the optimal transillumination of the abdominal wall might be compromised (Laasch 2003; Thornton 2000). Other conditions, such as inflammatory or infiltrative diseases of the gastric and abdominal wall, are considered relative contraindications to PEG (Nicholson 2000).

Contraindications to PRG

Following recent technical innovations, there are fewer contraindications to PRG than to PEG. The presence of gastric varices and portal hypertension increases the risk of bleeding significantly, and these are seen as absolute contraindications to PRG. Percutaneous access to the stomach could be challenging if the individual has undergone colonic interposition; some authors regard this as a relative contraindication when using infracolonic methods (Mirich 1990). Similarly, the interposition of liver could be a relative contraindication with the use of computed tomography or ultrasound guidance (Given 2005). The presence of ascites has previously been regarded as an absolute contraindication to PRG, as leakage and infection of ascites may occur during this procedure. However, some authors consider ascites only a relative contraindication to PRG, as the technique can be safely performed by carrying out pre-procedural paracentesis or gastropexy, or both (Shin 2010). In individuals who have undergone previous gastric or upper gastrointestinal surgery, the gastric remnant does not distend as normal stomach does, rendering gastric access more difficult. However, it is still possible to find an appropriate route for gastrostomy with the assistance of special techniques such as gastric distension using a balloon and computed tomography guidance (Foutch 1990; Sanchez 1992). As a result, a postoperative stomach does not preclude PRG even though more difficulties might be encountered.

Success rates for PEG/PRG

The success rates reported for PEG and PRG vary markedly among studies, and could be reasonably explained by differences in participant selection and operator experience. There are more contraindications to PEG than to PRG, and PEG is associated with more anatomical or technical limitations. In one study, individuals were usually converted to PRG when PEG was contraindicated or had failed, which may reflect the fact that PRG is superior to PEG in terms of technical feasibility (Thornton 2002). Some large series studies reported a higher success rate for PRG (99% to 100%) than for PEG (95.5 to 98%) (de Baere 1999; Laasch 2003; Leeds 2010; Rosenzweig 1994). In one study, which included 20 participants with amyotrophic lateral sclerosis, the success rate for PEG was reported to be as low as 55% (Thornton 2002). An historical meta-analysis involving 5752 participants concluded that the rate of successful gastrostomy with PRG was higher than that with PEG (99.2% versus 95.7%, respectively). However, this study suffered a major limitation in that most studies included in the meta-analysis were not comparative studies (Wollman 1995). The most commonly reported reasons for the failure of PEG were obstacles impeding the insertion of the endoscope (e.g. tumours in the upper gastrointestinal tract) and the difficulty of transilluminating the anterior abdominal wall (Desport 2005). On the whole, the current evidence favours a higher success rate for PRG than for PEG in the general population, but this needs to be validated in RCTs. Furthermore, the operator's experience and facilities available should also be taken into consideration when choosing the technique.

Major/minor complications with PEG/PRG

Based on the available evidence, most authors support PEG and PRG as safe procedures for enteral feeding; complications are generally infrequently encountered, although both techniques have the potential to cause mortality and morbidity. Documented major complication rates for PEG and PRG are 0% to 8% and 1.4% to 5.6%, respectively (Chandu 2003; Dwyer 2003; Hujala 2004; Möller 1999; Neeff 2003; Rimon 2005). Complication rates for PEG and PRG have been compared directly in some studies; however, results were contradictory (Eze 2007; Grant 2009; Lawrance 2003; Neeff 2003; Rustom 2006). Some studies found similar results in terms of complication rates for PEG and PRG (La Nauze 2012; Leeds 2010). However, a meta-analysis of earlier studies, including 5752 participants, which assessed outcomes for PEG and PRG found that major complications were less frequently seen with PRG than with PEG (5.9% versus 9.4%, respectively), and that 30-day mortality

was higher in the PEG group than in the PRG group (0.53% versus 0.3%, respectively) (Wollman 1995). In contrast, another meta-analysis that included 2379 individuals with head and neck cancer undergoing PEG or PRG found PRG to be associated with higher rates of major complications and mortality than PEG (Grant 2009). In a more recent systematic review that also assessed outcomes of PEG and PRG in individuals with head and neck cancer, evidence from four retrospective comparative studies favoured PEG over PRG with reference to mortality and peritonitis (Burkitt 2011). However, current meta-analyses have some common limitations, making it difficult to draw a definitive recommendation as to the safety of either method. First, most studies included in these analyses were retrospective and not RCTs, and so are subject to significant reporting bias. Second, the majority of studies were characterised by a lack of detailed descriptions of participant selection criteria and the procedure studied; the heterogeneous nature of the population in whom percutaneous gastrostomy is indicated makes comparisons within the literature more difficult. Third, the small size of the samples in most studies could reduce the power to detect significant differences between groups. Finally, the means by which complications were reported were inconsistent among studies; different definitions for major and minor complications could have led to confusion. To date, no RCT has been reported that has compared outcomes between PEG and PRG; hence, the currently available evidence is far from sufficient to determine which procedure is safer than the other.

Long-term results for PEG/PRG

As the ultimate goal of PEG/PRG is to provide nutritional support, it is necessary to evaluate the impact of these techniques on long-term outcomes. For most individuals, tube feeding via gastrostomy is sustaining in the long term, but it is doubtful that all feeding techniques may impact equally on nutritional status, quality of life and long-term survival. Assessing results over a long time frame (not only hospital stay, but also postdischarge) will give us more detailed information about the optimal feeding technique. Desport 2005 carried out a nutritional examination in 50 individuals with amyotrophic lateral sclerosis 364 (± 434) days after PEG or PRG and found a comparable improvement in nutritional status, as assessed by weight, triceps skinfold and mid-arm muscle circumference, with both techniques. No significant difference in survival was found between groups (Desport 2005), consistent with the results of a previous study (Thornton 2002). Survival and nutritional status were also investigated in individuals with motor neurone disease following enteral tube feeding; again, no difference in survival between individuals undergoing PEG or PRG was detected (Rio 2010). In a mixed population, Leeds 2010 compared 170 PRGs with 233 PEGs and demonstrated similar 30-day, 90-day and 1-year survival between groups. This conclusion has been confirmed by other authors who found no significant difference in 30-day and 1-year mortality rates between PEG and PRG within a median follow up of 405 days (La Nauze 2012). However, it was reported that tube function tended to be inferior with PRG within a median follow up of 17.2 months compared with PEG (PRG 58%; PEG 68%), but the difference did not reach statistical significance (Cosentini 1998).

Beyond clinical outcomes and nutritional status, the impact of treatment on individuals' quality of life should also be taken into account when evaluating a gastrostomy method. Unfortunately, few studies have compared quality of life following PEG or PRG. A study in 100 participants undergoing PEG assessed quality of life pre- and 6 months after PEG; a significant improvement from baseline in Quality of Life Index scores was achieved with PEG (19.25 ± 11.85 versus 30.08 ± 27.74) (Hossein 2011). More well-conducted studies are required in order to evaluate long-term results for PEG and PRG.

Summary of main results

Clinical reports have shown the feasibility and safety of PEG and PRG in selected individuals with swallowing disturbances; both techniques are effective options for administering enteral nutrition. However, the current evidence remains insufficient to draw any conclusion regarding which is superior to the other. Well-designed and conducted RCTs are required to answer this question (Summary of findings for the main comparison).

AUTHORS' CONCLUSIONS

Implications for practice

A lack of randomised controlled trials (RCTs) limits the implications for practice that can be drawn from this review. This review failed to reach a firm conclusion with regard to the optimal percutaneous gastrostomic method for individuals with swallowing disturbances. PEG or PRG should therefore be selected on the basis of patient indications and contraindications, the operator's own experience and the facilities available.

Implications for research

Large-scale and well-designed RCTs are required to compare the outcomes of PEG and PRG in individuals with swallowing disturbances. Future research should address the following issues:

- the benefit of PEG/PRG in different patient subgroups;
- the influence of PEG/PRG on the improvement of malnutrition;
- the influence of different technical modifications to PEG/PRG on patient outcomes;
- the objective assessment of both short- and long-term outcomes (e.g. quality of life).

ACKNOWLEDGEMENTS

We would like to thank Sarah Rhodes, Anika Rosenbaum, Leopoldo Lopez Roses for their important comments on the protocol, and thank Cochrane Upper Gastrointestinal and Pancreatic Diseases Group, Karin Dearness and Racquel Simpson for their work on the review.

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CHARACTERISTICS OF STUDIES

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Allen 2012	Retrospective study (conference abstract)
Allen 2013	Retrospective study (publication of *Allen 2012*)
Barber 2010	Observational study, no comparison between PEG and PRG
Barkmeier 1998	Retrospective study
Blondet 2010	Retrospective study
Bouteloup 2006	Review
Brady 2009	Retrospective case-control study, no comparison between PEG and PRG
Burkitt 2011	Systematic review
Campbell-Taylor 2008	Review, no comparison between PEG and PRG
Cook 2009	Review, no comparison between PEG and PRG
Cosentini 1998	Retrospective study
Cowen 1997	Retrospective cohort study, not relevant to PRG
Dennis 2005	Not relevant to PRG
Dennis 2006	Commentary
Dennis 2006a	Not relevant to PRG
Desport 2005	Non-randomised controlled study
Eze 2007	Retrospective study
Fang 2007	Review
Foote 2004	Randomised controlled trial about the placement of postpyloric feeding tubes rather than gastrostomy
Galaski 2009	Retrospective study
Galletti 2001	Retrospective study
Gledhill 2011	Retrospective study, no comparison between PEG and PRG

Study	Reason for exclusion
Grant 2009	Non-randomised controlled study
Greenwood 2013	Review
Guo 2010	Not relevant to PEG and PRG
Hoffer 1999	A randomised study about gastrojejunostomy other gastrostomy
Katzberg 2011	Systematic review
La Nauze 2012	Retrospective study
Laasch 2003	Non-randomised controlled study
Langmore 2009	Review
Laskaratos 2012	Retrospective study, no comparison between PEG and PRG
Laskaratos 2012a	Retrospective study
Leeds 2009	Prospective non-randomised study (conference abstract of *Leeds 2010*)
Leeds 2010	Prospective non-randomised study comparing PEG and PIG
Nah 2010	Retrospective study
Neeff 2003	Retrospective study
Nguyen 2006	Non-controlled trial, not relevant to PRG
O'Dowd 2004	Review
Osborn 2013	Observational study, no comparison between PEG and PRG
Piquet 2006	Review
Rio 2010	Retrospective study
Rustom 2006	Retrospective study
Sampson 2009	Systematic review, no comparison between PEG and PRG
Silander 2013	Not randomised controlled trial, not relevant to PRG
Silas 2005	Retrospective study
Spelsberg 2013	Retrospective study, not relevant to PEG
Terre 2007	Not relevant to PEG and PRG
Thomas 2008	Commentary
Thornton 2000	Before-after study, not randomised controlled trial
Thornton 2002	Retrospective study

Study	Reason for exclusion
Wollman 1995	Retrospective study
Wollman 1997	Retrospective study

APPENDICES

Appendix 1. CENTRAL search strategy

1. deglutition disorders/ or esophageal motility disorders/ or esophageal achalasia/ or esophageal spasm, diffuse/ or plummer-vinson syndrome/
2. (deglutition adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).mp. [mp=title, original title, abstract, floating sub-heading, study name, keyword and heading words, mesh headings]
3. Dysphagia.mp.
4. (Swallowing adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).mp. [mp=title, original title, abstract, floating sub-heading, study name, keyword and heading words, mesh headings]
5. or/1-4
6. Gastrostomy/
7. Enteral Nutrition/
8. Intubation, Gastrointestinal/
9. or/6-8
10. (endoscopic adj10 gastrostomy).mp.
11. Radiography, Interventional/
12. (radiologic adj10 gastrostomy).mp.
13. (ultrasonography or sonography).mp.
14. Endosonography/
15. Ultrasonography, Interventional/
16. Fluoroscopy.mp.
17. Echography.mp.
18. or/11-17
19. 5 and 9 and (10 or 18)

Appendix 2. MEDLINE search strategy

1. randomised controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. drug therapy.fs.
6. randomly.ab.
7. trial.ab.
8. groups.ab.
9. or/1-8
10. exp animals/ not humans.sh.
11. 9 not 10
12. deglutition disorders/ or esophageal motility disorders/ or esophageal achalasia/ or esophageal spasm, diffuse/ or plummer-vinson syndrome/
13. (deglutition adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier]
14. Dysphagia.mp.

15. (Swallowing adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word, unique identifier]
16. or/12-15
17. Gastrostomy/
18. Enteral Nutrition/
19. Intubation, Gastrointestinal/
20. or/17-19
21. (endoscopic adj10 gastrostomy).mp.
22. Radiography, Interventional/
23. (radiologic adj10 gastrostomy).mp.
24. (ultrasonography or sonography).mp.
25. Endosonography/
26. Ultrasonography, Interventional/
27. Fluoroscopy.mp.
28. Echography.mp.
29. or/22-28
30. 16 and 20 and (21 or 29)
31. 11 and 30

Appendix 3. EMBASE search strategy

1. Clinical trial/
2. Randomized controlled trial/
3. Randomization/
4. Single-Blind Method/
5. Double-Blind Method/
6. Cross-Over Studies/
7. Random Allocation/
8. Placebo/
9. Randomi?ed controlled trial$.tw.
10. Rct.tw.
11. Random allocation.tw.
12. Randomly allocated.tw.
13. Allocated randomly.tw.
14. (allocated adj2 random).tw.
15. Single blind$.tw.
16. Double blind$.tw.
17. ((treble or triple) adj blind$).tw.
18. Placebo$.tw.
19. Prospective study/
20. or/1-19
21. Case study/
22. Case report.tw.
23. Abstract report/ or letter/
24. or/21-23
25. 20 not 24
26. exp esophagus function disorder/
27. (deglutition adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer]
28. exp Dysphagia/ or Dysphagia.mp.
29. (esophageal adj10 achalasia).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer]
30. (esophageal adj10 spasm*).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer]

31. plummer-vinson syndrome.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer]
32. (Swallowing adj5 (disturbance$ or disorder$ or difficult$ or dysfunction$ or impair$ or condition$ or abnormal$ or damage$ or injur$)).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer]
33. or/26-32
34. Gastrostomy/
35. enteric feeding/
36. exp digestive tract intubation/
37. or/34-36
38. (endoscopic adj10 gastrostomy).mp.
39. interventional radiology/
40. (radiologic adj10 gastrostomy).mp.
41. Fluoroscopy.mp.
42. (sonography or endosonography or ultrasonography).mp.
43. Echography/
44. Endoscopic echography/
45. or/39-44
46. 33 and 37 and (38 or 45)
47. 25 and 46

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DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- West China Hospital, China.
- Sichuan University, China.

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Due to a lack of RCTs identified, some data analyses specified in the protocol could not be carried our in the full review process. The discussion section is a general review of percutaneous gastrostomy based on the evidence available, derived from retrospective studies, case series or non-randomised controlled studies.

INDEX TERMS

Medical Subject Headings (MeSH)

Deglutition Disorders [*complications]; Enteral Nutrition [*methods]; Gastrostomy [*methods]

MeSH check words

Humans